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AUTHOR Marker, Gerald W.
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ABSTRACT

The focus of the curriculum in the elementary schools today is on reading, writing, and mathematics, an emphasis reinforced by state competency testing programs. This trend is lamented by science and social studies educators who argue that one of the major goals of today's education should be to produce citizens who are technologically literate. This requires that: (1) students understand the link between technology, themselves, and society in general; (2) elementary students understand the relationship between technology and social change; (3) students understand that most science/technology/society (S/T/S) issues involve conflicting assumptions, interpretations, and opinions; (4) students should not feel powerless in the face of complex S/T/S issues; and (5) youngsters should come to value a scientific approach to understanding their world and universe. Topics addressed include: the unique contributions of history and social science, the area of values and S/T/S, and the question of how to move S/T/S into elementary social studies. (BZ)

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Gerald W. Marker

Indiana University

Bloomington, Indiana

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Including Science/Technology/Society Issues in Elementary School Social Studies: Can We? Should We?

Gerald W. Marker
Indiana University

Science and social studies educators alike lament the small proportion of the elementary curriculum devoted to their respective subjects. Both groups easily document their cases, leaving one to wonder why anyone would propose that the two groups join in pushing for the inclusion of science/technology/society components in an already crowded curriculum, yet that is exactly the proposal around which this paper is constructed.

Why S/T/S in the Elementary Curriculum?

The focus of the curriculum in the elementary schools today is upon reading, writing, and mathematics, an emphasis reenforced by state competency testing programs. How then can it be argued that room should be made for S/T/S issues? Shamos sets forth one reason:

> Times are changing. We are moving into a more pronounced technological age, one in which technology promises to touch more closely the lives of most people. The work place generally will expect from its employees a better understanding of technology than ever before. Thus

> where there were few, if any, incentives in the past for one to become literate in science, there may be very compelling reasons in the future for widespread technological literacy.[1]

Quite simply, the world rushes on; technology increasingly inserts itself into all aspects of our lives. In most cases technology enriches and smooths our daily endeavors but technology also carries with it unanticipated side effects and/or hidden costs. As technology becomes increasingly complex people feel a growing sense of being powerless, a sense of being the victims of technology rather than its masters.

The notion that people would shape their own destiny rather than leaving it to the will or fate of some superior power is a relatively recent development. The idea that we do have some responsibility for our fate may even be a contributing factor to the feeling that our world has gotten so complex that events are now out of control.

This tight link between technology and progress confronts policy makers the world over but in democratic societies such as ours it brings with it special problems.[2] A key assumption of democracies is that the general population should directly or indirectly have a hand in making public policy. The notion that each should have an equal voice in decisions is deeply embedded in our values. But as issues become increasingly complex uninformed votes threaten the very principles which make them possible. The decision, for example, of whether to build another fire

station in a rapidly growing part of the city is of a quite different level of complexity from one involving the best way to dispose of PCB contaminated soil. Anderson has characterized the dilemma of uninformed participation as a "double-edged sword."

There are those among us who would solve this dilemma by having us return to simpler times but for most of us such proposals are not attractive options even if they were possible. Besides, one need only recall high infant mortality rates, long days of heavy physical labor, and plagues that swept entire populations to remember that while life in the "good old days" may have been simpler it was not necessarily better. Technology seems here to stay.

Technology may be here to stay but it is hardly neutral. Rather, as has already been suggested, our world of technology is full of what Robert Hanvey has called "surprise effects" which present us with some very tough choices. For example, our nation runs on electricity; no one suggests that we abandon its use. But, how should we generate that power? Coal fired power plants appear to cause acid rain, nuclear power may be unsafe, oil and natural gas supplies are on the decline and increasingly under the control of other nations. There is no easy or obvious choice.

Clearly technology plays a role in shaping our values but so too do our values shape the future of both science and technology. Technology now makes host parents and sperm banks possible but the future of such activities lies not so

much with science and technology as with the social context in which they exist.

The distinction between social and scientific issues becomes increasingly blurred. If we are to continue the practice of allowing the general population to participate in making social policy we simply must increase the level of technological literacy of our population. The remainder of this paper will set forth the argument of why elementary school social studies should be a part of that effort.

Major Goals of S/T/S in the Schools

If one accepts the preceding arguments then it follows that one of the major goals of today's education should be to produce citizens who are technologically literate. The National Science Teachers Association has described a person with such literacy but from a social studies perspective what does it mean to be technologically literate?[3]

First, and perhaps most importantly, it means students who understand the link between technology, themselves, and society in general, not just their society, but all societies. This means not only understanding how technology effects their lives in 1987, but how it effected the lives of their ancestors.

Second, elementary students need to understand the relationship between technology and social change. They need to understand what is meant by the notion that while

necessity may be the Mother of invention, culture is often the Mother of necessity.

Third, they need to understand that most S/T/S issues involve conflicting assumptions, interpretations, and options. They should know that few issues are as simple as they seem while at the same time realizing that what they know and feel about S/T/S issues does make a difference.

Forth, they should not feel powerless in the face of complex S/T/S issues. They should have the necessary data collection and decision making skills to enable them to make intelligent choices among options and to know when they should defer decisions to others.

Finally, youngsters should come to value a scientific approach to understanding their world and universe. They should see that human behavior is governed by principles, principles which can be discovered by those same humans. Human behavior in all its aspects should not be seen as a mystery but as the result of the interaction of social, cultural, and biological forces.

If the elementary school curriculum could contribute these five elements to the technological literacy of children those of us interested in S/T/S would be well served.

The Unique Contributions of History and Social Science

The wonders of technology and its impact on the lives of those who use it is nothing new, despite what elementary school youngsters may believe. Shamos said it well:

> The development of civilization since the Middle Ages is closely linked with the history of technology -- much more so than with the history of science and mathematics -- for since that period nations have encouraged industrialization by granting exclusive rights to monopolies for the development of innovative products or processes. This led in the Renaissance to the establishment of the first modern patent system, which ultimately provided much of the incentive for the industrial revolution and the setting for contemporary science. Thus there is a strong rational for understanding the role played by technology in the development of modern civilization, and its probable role in the future evolution.[4]

Donald Manley has suggested that if students are to understand how we came to what we are today they should study the impact of major technological developments. He suggests three major units:

1. The development of tools and machines and their contribution to the growth of civilization.
2. The development of power and energy and their contribution to the growth of civilization.
3. The development of communication and transportation and their contribution to the growth and development of civilizations.[5]

Manley goes on to suggest, for example, that the unit on power include concepts such as sail, waterwheel, steam

engine, electric motor, paddle wheel, treadmill, battery, windmill, generator, turbine, and internal combustion engine. Each of these inventions had a major social impact, including some which were unanticipated. Many of the concepts proposed by Manley are already included in elementary social studies units, although their present purpose may not be to illustrate the relationship between technology, society, and social change.

Sara Anderson has suggested a slightly different approach for obtaining an historical view of technological innovations. She lists ten questions which students can ask when they study a past technological innovation.

1. List all the effects you can think of for one technological innovation introduced into our culture during the past 85 years.

2. Categorize the effects on your list according to whether they were planned and/or foreseen by those who introduced or eagerly adopted the innovation or were unplanned or unforeseen.

3. Indicate which effects were felt only in a local area, which were felt regionally, nationally and globally.

4. Divide the effects on your list into those you consider "positive," that is benefitting people in general and "negative," that is those which were harmful.

5. ...list four factors you consider essential to a good quality environment for human beings, and which influenced your choices in item # 4.

6. Which subgroups in society benefitted most from the innovation you are assessing? Which subgroups of society bear (or did bear) the majority of the burdens of the negative effects? List two reasons for the inequitable distribution of benefit and burden.

7. What was the timelapse between (a) the scientific or technological discovery which made the innovation possible and its widespread introduction or adoption? (b) between the planned benefits and the appearance and/or awareness of the burdens?

8. (a) What actions have been/are being taken to alleviate the burdens? (b) Who (government, industry, consumers) are taking these actions? (c) Who is paying the cost of alleviating these burdens in money? (d) Who is paying the cost of alleviating these burdens in Quality of Life?

9. What areas of CHOICE did the innovation open up for individuals?

10. What choices did the innovation open up for society in general (seen most likely in legislative and judicial decisions)?[6]

While different in their specifics, both Manley and Anderson show us how history can be used to help children understand how closely coupled are technology and social change, how technology almost always involves a series of trade-offs and unexpected side effects. By modifying an item or two Anderson's list of questions could also be used to think about proposed innovations.

Since history is widely taught in the intermediate grades the perspective being proposed here could be accomplished with a shift in emphasis from wars, capitols, presidents, and exports to the relationship between society and technology.

Elementary social studies also includes a considerable emphasis upon other cultures. Typically the focus of such units of study is upon the diversity of how humans relate to their physical environment. Without major adjustments the

focus could shift to how other cultures deal with technology. Students could see how the introduction of "foreign" technology such as snowmobiles in Lapp society or transistor radios in India have ramifications beyond those planned or intended. Once students understand such a perspective they can be helped to turn it back upon an analysis of their own culture and its relation to technology.

The economics of technology has already been suggested. Technology always involves the allocation of resources. For example, is the development of a Star Wars defense system more important for the society than providing catastrophic health insurance for older citizens? Is the reduction of acid rain more important than holding the line on electric rates?

The politics of S/T/S/ also has a place in the social studies curriculum of elementary schools. At the base of all political systems is the process of allocating power. Technology has always been linked to the power allocation process. History is full of examples of where power went to those who could take it, and weapons often provided that means. Today the control of, and access to, information greatly influence the distribution of power. Even struggles over whether we should have a nuclear based, highly centralized system of energy distribution or a decentralized, appropriate technology system are in some ways a debate over political power and control.[7]

After history, more time in elementary social studies is spent on what could be classified as geography than upon any of the other social sciences. Place names receive much attention, as do exports and imports. Food, clothing, and housing seem to get a lot of attention. Again, current practice lends itself to the inclusion of an S/T/S perspective. For example, the technology of air conditioning now allows habitation where before only adventurers cared to live. Refrigeration allows the world wide movement of food products so while diets are still distinctive technology is making them less so.

In short, history and the social sciences (social studies in the schools) bring a somewhat different perspective to S/T/S issues. While it is perhaps natural for people in the sciences to view the field as SCIENCE/ Technology/ Society those of us from the social sciences probably view the concepts in their reverse order, i.e., Science/Technology/SOCIETY.

The Very Special Area of Values and S/T/S

This section appears near the end of this paper for good reason; no area has caused those of us in social studies more grief than this one.[8] Value analysis and value clarification have appeared on more school board agendas during the past few years than I care to remember. One is tempted to simply forget it, to believe that if we could accomplish the other

S/T/S related goals outlined earlier in this paper that we could have done enough! But the truth of the matter is that for most social studies educators preparing young people for democratic citizenship is probably THE most important reason for teaching social studies in the schools, either elementary or secondary.

The argument has already been made that S/T/S issues present democratic societies with unique problems. The general public finds itself taking positions on issues that are very complex, that carry with them all sorts of surprise effects, and about which the experts themselves cannot agree. It is in such a context that the society turns to the layman for a decision.

It is unrealistic to expect the schools to give students a level of technical knowledge which would permit them to make truly informed decisions over the entire range of areas represented by S/T/S issues. About all that can be hoped is that students can learn how to make such decisions and to practice those skills on a few issues so that the issues themselves are somewhat less mysterious. Besides, who among us would be willing to predict the specific choices which will await today's elementary age students by the time they become adults?

Patrick and Remy have described how "decision tree" strategies can be employed to develop the alternatives involved in civic decision making. The "tree" is rooted in the occasion for a decision. The occasion might be the issue

of how to dispose of spent fuel from nuclear power plants or what to do with toxic waste produced by the manufacturing process? Students then explore the values and goals that pertain to the decision opportunity. What, for example, should be the predominant value regarding the nuclear waste issue? Is halting the production of waste so important that we should abandon generating electricity with nuclear power and live with the consequences, whatever they are? Or do we continue with nuclear power but force each state to store "its fair share" of the waste? If all states do not possess equally suitable storage sites is the value of "equal distribution of risk" more important than effectiveness of storage?

The third component of the decision tree process is that of developing alternative responses to the decision opportunity. What are our options when it comes to storing nuclear waste? How do other nations cope with their storage of such waste? Can science and technology come up with still more options?

The final component of decision trees deals with the likely consequences, both negative and positive, of the alternatives identified in component three. It is at this point were students begin to get some idea of the interconnectedness of alternatives. They can begin to see that the choices are seldom between right and wrong but more often between good, better and best or bad, awful and worst.

There is no shortage of issues on which to practice the application of the decision tree process. In fact, science and technology are natural generators of highly controversial public issues. It is not important that students resolve the value dilemmas associated with each of these issues. What is important is that they can learn and practice the skills needed to deal with such issues.

Helping students learn to sort out and predict the consequences of various value positions will always be seen as threatening by some parents. Clarifying one's own values and speculating about the implications of applying them is a corrosive process if the values in question are dogmatically held. The best we can hope for is teachers who understand the difference between value analysis/clarification and value indoctrination and who practice the former rather than the latter.

Can We Move S/T/S into Elementary Social Studies?

Earlier sections of this paper have dealt with the questions of why and how S/T/S issues should be made a part of social studies in the elementary schools. But what is the likelihood that what has been proposed will actually happen? Shamos said it very nicely.

> The educational battlefield is littered with the pronouncements of those who have sought to persuade the U.S. public that understanding something about science is the sine qua non of an educated person. To date all efforts to develop such literacy have

> failed, including the massive effort that followed Sputnik, and there is no reason to believe that new attempts to achieve widespread public literacy in science will be any more successful. Two reasons for this stand out above others: First, the public remains unconvinced that the effort it must expend to gain a reasonable understanding of science is actually worth the prize. Clearly the average educated adult in the United States manages quite well in our society with little or no understanding of science, or for that matter, of mathematics beyond simple arithmetic. Knowledge of these disciplines is not perceived by the public as being essential to either the "good life" or to a successful career outside of science. Nor is there any stigma attached to being ignorant of science...Thus there is no incentive for the average U.S. citizen to become literate in science, either for economic reasons or because of peer pressure.[5]

One need only substitute S/T/S for science in the Shamos statement to see what we are up against. The rational for including S/T/S issues in the elementary curriculum has already been stated. But HOW we go about it can increase our chances of success.

If S/T/S is to have a chance in the elementary schools it will not be as a new course! As stated at the very outset of this paper, science and social studies already receive a meager share of the elementary curriculum. The allocation of additional time to either subject is unlikely.

There are at least two points of entry for S/T/S content other than through a new course. One is a different focus for existing topics and units. The second is the insertion of new topics into the social studies curriculum.

Much of what goes on in elementary social studies is structured around unit topics or "problems." Examples of

units would include: Families Around the World; Producing Food, Shelter, and Clothing; How Our City is Governed; and The Industrial Revolution. Typical "problems" include: How Do People in the Cities Get their Food?; How Do We Make and Enforce Rules?; and How Have Ethnic Groups Contributed to Our Heritage? But these topics and problems could just as easily be ones tailored to S/T/S issues such as: What Causes Pollution and What Can Be Done About It?, Why Does Industrial Society Depend Upon Tools?, How Has Transportation Changed During the Past 100 Years?, Tools and Early Humans, The Role of Communication in Government, and The Global Supermarket. The focus of such units would be to develop the types of understandings and skills described earlier.

While new units and topics would be nice, they are not essential. Much of the current content of elementary social studies will serve quite nicely if we can get the focus shifted to technology and its relationship to society. A teacher can still teach her unit on "Transportation in the City", only now she can help students think about how streetcars changed the lives of city folks. A unit on "Modern Manufacturing and the Use of Robots" could lead to a discussion of the positive and negative consequences of robotics. A unit on "Communication in America" might probe into the changes brought to the American f by TV.

The point is that if we want to see S/T/S dealt with in the elementary schools we should infuse it into existing courses and topics rather than using the new course approach.

A Final Note

One might rightfully ask why the responsibility for S/T/S should be divided up among existing subjects such as science and social studies? Would it not be more efficient to create an interdisciplinary subject? While that might seem reasonable my response is that it probably will not work. School people think in terms of subjects. One of the things which has hampered my own field of social studies is that we cannot decide whether we are simply the sum of history and the social sciences or whether we are something unique. If we keep S/T/S as a set of topics and perspectives which we can fit into existing courses we have a chance. If not, our fate may be that of many previous "good ideas."

Notes

1. Shamos, p. 15.

2. An example of the cross-national nature of the problem can be found in the paper by Robert Smith.

3. Berkowitz reports the NSTA definition of technological literacy. It should also be noted that the National Council for the Social Studies has a standing committee on S/T/S issues and adopted S/T/S Guidelines which were published in the April, 1983, issue of Social Education.

4. Shamos, pp. 14-15.

5. Manley, p. 11.

6. Anderson, pp. 24-25.

7. Commoner

8. For a more detailed discussion of the controversial issues problem see the paper by Kay Cook.

9. Shamos, p. 9.

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